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Long term changes in the functioning of a karst aquifer under anthropogenic forcing

Cousquer Yohann and Jourde Hervé
Hydrosciences Montpellier, UMR 5569, France (yohann.cousquer@gmail.com)

A quantitative estimation of the sustainability of groundwater resources is a challenge for water supplies. This study focuses on karstic hydro systems, which provide water resources to a large part of the Mediterranean population. Here, we address the long-term changes in the functioning of the Lez karst aquifer, which has been providing water to the city of Montpellier since the XIXth century. Before 1965, only the natural overflow of the spring was used, then pumping in the spring, down to -6.50 m below the overflow level of the spring, was performed until 1981. After this date, the management of the water resource consisted in pumping groundwater at a much greater flow rate (up to 2000 l/s) than the natural discharge during low flow (200 l/s), which seasonally generates important drawdowns (down to ~25 m) at regional scale.

The available time series consist in more than 70 years of discharge and water table (with some gaps) that encompass the three kinds of groundwater management, spanning from a passive management to the current active management. The change in water budget terms over time (before and after active management) highlights the modification of transfers and storage in the different karst compartments (epikarst, unsaturated zone, saturated zone), and the climatic variability of precipitation, evapotranspiration at inter-annual. A lumped parameter model was set up in order to simulate spring discharge, while accounting for surface water and grandwater level dynamics, and better assess the changes in the storage dynamics within the different compartments (matrix-conduits) of the karst. A robust parameter estimation, accounting for groundwater discharge and surface water discharge observations, has been conducted using a Monte-Carlo procedure. In order to obtaines a robust model, divers data type such as groundwater flow, surface flow and water level, have been used. [H1] Once the model was calibrated over (1955-2020) reference period, several prospective management scenarios based on pumping discharge were simulated with an estimation of predictive uncertainty. This allowed evaluating the influence of pumping at large flow rate (active management) on the flux and storage on matrix-conduits exchanges of such karst hydrosystem. A modification on both the discharge rates and the direction of water exchanges between compartments, and especially between matrix and conduits, have been noted. The importance of climatic variability at inter-annual scale on water availability has been discussed as well.